In mechanics the term "moment" means the product of a weight in pounds multiplied by its distance in inches from the fulcrum. Some engineers have objected to this term, and it has been proposed to call this product lever inch pounds, and in preference I will use it. If a weight of 27 pounds is placed on a lever at 10 inches from the fulcrum, the inch pounds are 270. This means that 270 pounds placed on a lever at one inch from the fulcrum, produces the same statical effect as 27 pounds at 10 inches from it—or looking at it from another standpoint, if these weights are placed at their respective distance from, but on opposite sides of a fulcrum, they are in equilibrium. If in a question it was found that the lever inch pounds on one side of the fulcrum was 1,386 and on the other 1,322, a difference of 64, it follows that the lever is not in equilibrium, but that 64 pounds placed one inch from the fulcrum, on the 1,322 side, would make it. Or, in this case, the number 64 divided by any other weight in pounds, gives the distance in inches from the fulcrum where that weight must be placed to effect the same object.

In our common engineers' handbooks the principles of the lever are treated in an obscure and indirect manner. Mechanical writers have pointed this out. The only reason they could give for its perpetuation was the simplicity of the question, and that men competent to deal with it did not consider it worth their while. The handbooks tell us that there are three kinds or classes of levers. I intend to prove that they are alike in principle, and one rule governs and controls all of them.

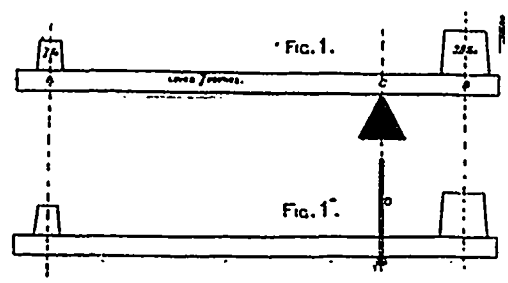
Fig. 1. Fig. 1a.

In the so-called first class there is a weight at each end of the lever, and the fulcrum is intermediate. Let the lever weigh 7 pounds, the small weight *A* 7 pounds, and the large weight *B* 28 pounds, the whole of the parts weighing 42 pounds. Balance the system on the fulcrum *C*; it will then be found that the system is in conformity with the law of the equality of inch pounds on each side of the fulcrum, and if one pound is placed on either side of the fulcrum, equilibrium is destroyed and motion would take place. But what I wish to call particular attention to is that here the pressure on the fulcrum is 42 pounds, that being the sum of the weights resting on it. No person can doubt this; it can be visibly proven on the platform of a scale; and if one of the weights is shifted on the lever the other must be shifted to maintain a balance. And still the pressure on the fulcrum is 42 pounds. It follows from this that when the pressure on the fulcrum and the weight on one side of the fulcrum are known, then the weight on the other side of the fulcrum is found by subtracting the last quantity from the first. The weight or pressure on the fulcrum is equal to the sum of all the others. This principle is an important factor in our question. It will be observed (Fig. 1) that if the system, instead of resting on a fulcrum, was suspended from the same place that it rested on the fulcrum, the balance would be undisturbed, and what was formerly a pressure of 42 pounds is now a tension of the same amount.

The division of levers into three classes is more nominal than real. All of its applications can be resolved under one general rule. If, as in Fig. 2, we

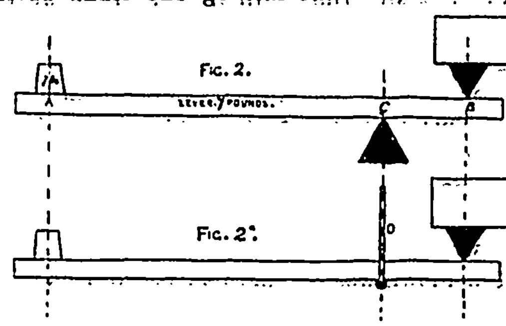
Fig. 2. Fig. 2a.

introduce a fulcrum, or more properly, a fixed or immovable point acting at the same place on the lever that the 28-pound weight did, and with the 7-pound weight at the same position of equilibrium on the lever, the pressure at *B* is equal to a weight of 28 pounds, and the pressure at the intermediate fulcrum *C* remains 42 pounds, or, if suspended from *C* and the intermediate fulcrum removed as in Fig. 2*a*, the tension on the rod *D* is also 42 pounds. This can be proven by making the experiment on the platform of a scale, or suspending the system from a steelyard.

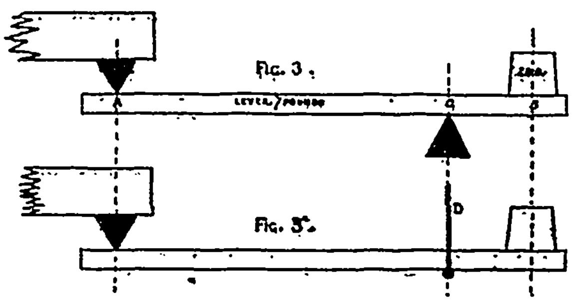
Fig. 3. Fig. 3a.

Again in Fig. 3, the intermediate fulcrum and the 28 pound weight are retained in their former position on the lever; but a fulcrum or fixed point is substituted for the 7 pound weight at *A*. No change has taken place; the pressure at *A* is equal to a weight of 7 pounds, and, as formerly, 42 pounds at *C*. The results are the same if suspended from *C* as in Fig. 3*a*.

From this it will be readily understood that *A*, *B* or *C* may be considered at option, either fulcrum, weight or power, according to the requirements of the mechanism, and that a change in name, or the substitution of an equivalent pressure or tension for a weight, entails no change in principle.

In accordance with the above, the intermediate force in the lever safety valve is the pressure of steam on the valve that acts vertically and in line with its axis, and directly opposed to all the others. The resultant of the system is on this line, and all measurements required in calculating lever inch pounds are taken from it. The opposing forces that are to be in equilibrium with a given steam pressure, are the weight of the lever, the valve, the pea, and the pressure of the lever on the pin, which is a variable quantity depending on the position of the pea on the lever, and in the solution of this question it has to be found, which is easily done by subtracting the known weights from the total required.

In an actual working valve the lever weighed $9\frac{1}{8}$ pounds; it balanced at a point $16\frac{1}{4}$ inches from the centre of pin hole, or $11\frac{5}{8}$ inches from the valve axis, the distance between the valve axis and centre of pin hole being $4\frac{5}{8}$ inches. The weight of the valve and an intermediate piece between it and the lever was $4\frac{7}{8}$ pounds, and the weight of the pea 62 pounds. Total